

# **Draft Itchepackesassa Creek, WBID 1495B, Florida**

## **Dissolved Oxygen and BOD**

### **Total Maximum Daily Load**

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**SUMMARY SHEET**  
**Total Maximum Daily Load (TMDL)**

**1. 303(d) Listed Waterbody Information**

**State:** Florida

**County:** Hillsborough

**Major River Basin:** Tampa Bay Basin (HUC 03100205)

Waterbody (List ID)	Listing Year	Impairment(s)	Pollutant(s)
Itchepackesassa Creek (WBID 1495B)	1998	Dissolved Oxygen (DO)	Natural wetland DO consumption
Itchepackesassa Creek (WBID 1495B)	1998	Biochemical Oxygen Demand (BOD)	BOD

2. TMDL Endpoints (i.e., Targets) for Class III Waters (fresh):  
Dissolved Oxygen (DO) shall not be less than 5.0 milligrams/L. Normal daily and seasonal fluctuations above these levels shall be maintained.

**3. Pollutant Allocations for WBID 1442**

Pollutant	TMDL	WLA		LA	MOS
		Continuous	MS4		
Dissolved Oxygen (DO)	756 kg/d	53 kg/d	703 kg/d	703 kg/d	implicit
Biochemical Oxygen Demand	376 kg/d	53 kg/d	292 kg/d	292 kg/d	32 kg/d

4. Endangered Species (yes or blank):

5. EPA Lead on TMDL (EPA or blank): EPA

6. TMDL Considers Point Source, Nonpoint Source, or both: Both

7. Major NPDES Discharges to surface waters addressed in EPA TMDLs:

Facility Name	NPDES No.	Facility Type	Impacted Stream
Plant City Water Reclamation Facility	FL0026557	Domestic WTP	East Canal, Itchepackesassa Creek, Blackwater Creek
CSX Transportation	FL0032581	Contact Stormwater Runoff	Winston Creek, Itchepachesassa Creek, Blackwater Creek

## INTRODUCTION

The U.S. Environmental Protection Agency is proposing this Total Maximum Daily Load (TMDL) for Itchepackesassa Creek (WBID 1495B) as required by the 1999 Consent Decree in *Florida Wildlife Federation, Inc., et al. v. Browner, et al.*, Northern District of Florida, Civil Action No. 4: 98CV356-WS. .

The U.S. Environmental Protection Agency (EPA) has analyzed the available data and information for this waterbody, and has determined that this waterbody is *likely* not meeting the State of Florida's applicable water quality standard for dissolved oxygen (DO) due to naturally-occurring conditions. If the waterbody is not meeting its applicable water quality standards due to natural conditions, a TMDL would not be necessary nor would it be required by the consent decree. Florida's water quality standards recognize that some deviations from water quality standards occur as the result of natural background conditions, that is, the condition of the water in the absence of man-induced alterations. Florida's water quality standards also set out how the State is to establish the appropriate criteria for an altered waterbody, that is, where it can be demonstrated that the deviations would occur in the absence of any human-induced discharges or alterations to the water body. For such altered waterbodies, the State may establish a site-specific alternative criteria, based upon a similar unaltered waterbody or on historical pre-alteration data.

However, the existing data and information does not provide certainty that the deviations from the DO water quality standard are naturally occurring. EPA is therefore fulfilling its court-ordered commitment by proposing a TMDL for this waterbody. The TMDL, as proposed, indicates that the existing water quality standard for DO is not attainable in this waterbody, and therefore, recommends that the State of Florida establish a site-specific criterion for DO for this waterbody.

Section 303(d) of the Clean Water Act requires each state to list those waters within its boundaries for which technology based effluent limitations are not stringent enough to protect any water quality standard applicable to such waters. Listed waters are prioritized with respect to designated use classifications and the severity of pollution. In accordance with this prioritization, states are required to develop Total Maximum Daily Loads (TMDLs) for those water bodies that are not meeting water quality standards. The TMDL process establishes the allowable loadings of pollutants or other quantifiable parameters for a waterbody based on the relationship between pollution sources and in-stream water quality conditions, so that states can establish water quality based controls to reduce pollution from both point and non-point sources and restore and maintain the quality of their water resources (USEPA, 1991).

The Florida Department of Environmental Protection (FDEP) has developed 303(d) lists since 1992. The list of impaired waters in each basin, referred to as the Verified List, is also required by the FWRA (Subsection 403.067[4]), Florida Statutes [F.S.]). However, the FWRA (Section 403.067, F.S.) stated that all previous Florida 303(d) lists were for planning purposes only and directed the Department to develop, and adopt by rule, a new

science-based methodology to identify impaired waters. After a long rule-making process, the Florida Environmental Regulation Commission adopted the new methodology as Chapter 62-303, Florida Administrative Code (F.A.C.) (Identification of Impaired Surface Waters Rule, or IWR), in April 2001. The TMDLs developed in this report are for impaired waters on the 1998 303(d) list but not on FDEP's verified list.

## PROBLEM DEFINITION

Itchepackesassa Creek, WBID 1495B is on the 1998 303 (d) list for low dissolved oxygen, and biochemical oxygen demand. This TMDL will address the low DO and BOD impairment.

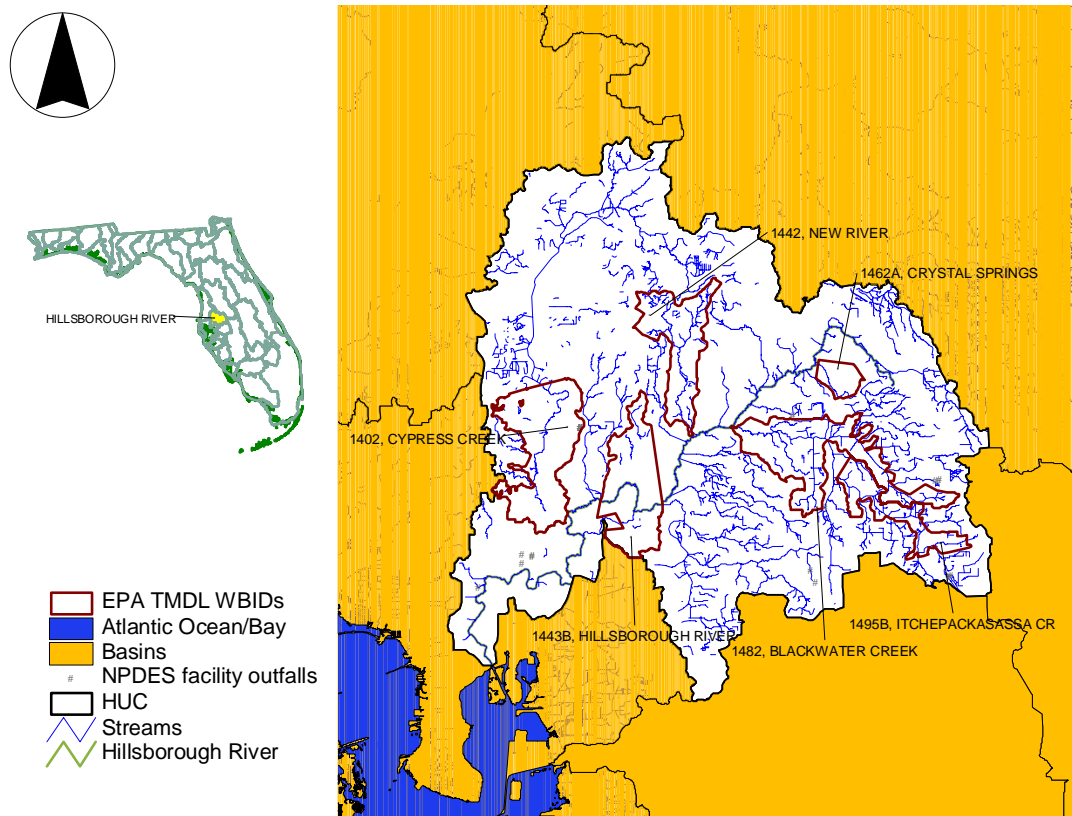


Figure 1: Tampa Bay Tributaries, Impaired WBIDs that EPA is addressing

## **WATERSHED DESCRIPTION**

The FDEP Water Quality Assessment Report describes the Hillsborough River Basin which begins east-northeast of Zephyrhills and drains 690 square miles before emptying into the upper Hillsborough Bay, a part of Tampa Bay. Its headwaters originate in the southwestern portion of the Green Swamp, where it also receives overflow from the Withlacoochee River. The river channel is not clearly defined until the river leaves the swamp. From there, it flows southwesterly 54 miles to upper Hillsborough Bay.

Perennially flowing tributaries to the Hillsborough River are Big Ditch and Flint Creek. Intermittent streams are Indian Creek, New River, Two Hole Branch, Basset Branch, Hollomans Branch, Clay Gully, Trout Creek, Blackwater Creek, and Cypress Creek. High floodwaters are diverted from the Hillsborough River at the confluence of Trout Creek and upstream of the Tampa Reservoir Dam through the Tampa Bypass Canal to McKay Bay.

Channelization has extended Sixmile Creek west and north to intersect the Hillsborough River at two points, the confluence of Trout Creek and near the midpoint of the Tampa Reservoir, which supplies drinking water to the city of Tampa. The modified Sixmile Creek was then renamed the Tampa Bypass Canal, which comprises two canals. The Harney Canal (C-136) runs from the Tampa Reservoir to join the second and longer canal, C-135, which connects the Hillsborough River at Trout Creek and Palm River. Both canals control flooding in the city of Tampa. Urban and built-up areas dominate the landscape in the southern quarter of the planning unit, which includes the urban and suburban areas of Tampa, Plant City, and Lakeland. In the upper half of the planning unit (to the north), urban and suburban areas appear as an east-west band encompassing Zephyrhills, Wesley Chapel, and Land O' Lakes. Together, urban and built-up lands comprise 25 percent of the total area. Within the region, which is characterized by expanding population growth and land development, large areas of swamps and forested uplands remain undeveloped along portions of the Hillsborough River and its principal tributaries. Together with other undeveloped lands, natural lands (uplands and wetlands) comprise 39 percent of the planning unit.

Throughout most of the rest of the planning unit, particularly in the upper reaches of its tributaries, land uses are primarily rangeland, pasture, and agriculture, including citrus groves and row crops. The greatest acreages of citrus are found around Land O' Lakes, in the Plant City/Dover/Seffner area south and east of Lake Thonotosassa, in the area around Lakeland, and in a wide area north of Zephyrhills. Generally, the northern and central portions of the watershed are rural, while the southern portions are mainly urban and industrial. However, suburban development radiating from major urban areas such as Tampa is spreading into rural areas.

Additional information about the river's hydrology and geology are available in the Basin Status Report for the Tampa Bay Tributaries Basin (Florida Department of Environmental Protection, 2003). For assessment purposes, the Florida Department of Environmental Protection (the Department) has divided the Tampa Bay Tributaries Basin into water assessment polygons with a unique **waterbody identification (WBID)** number

for each watershed or stream reach. The Hillsborough River has been divided into WBIDs or segments and this TMDL addresses WBID1495B.

Several tributaries to the Hillsborough River are also impaired, such as Blackwater Creek, Cow House Creek, and Crystal Springs. There are 127 permitted domestic and industrial facilities in the Hillsborough River planning unit. Urban land comprises 25 percent of the planning unit, natural lands comprise 39 percent, rangeland, pasture, and agriculture make up the rest of the planning unit.

Itchepackesassa Creek is impaired for DO and BOD.

## **WATER QUALITY STANDARD AND TARGET IDENTIFICATION**

Florida's surface waters are protected for five designated use classifications, as follows:

Class I	Potable water supplies
Class II	Shellfish propagation or harvesting
Class III	Recreation, propagation, and maintenance of a healthy, well-balanced population of fish and wildlife
Class IV	Agricultural water supplies
Class V	Navigation, utility, and industrial use (there are no state waters currently in this class)

Waterbodies in the Hillsborough River Basin are classified as freshwater Class III waters, with a designated use classification for recreation, propagation and maintenance of a healthy, well-balanced population of fish and wildlife. The water quality criteria for protection of Class III waters, are established by the State of Florida in the Florida Administrative Code (F.A.C.), Section 62-302.530. The individual criteria should be considered in conjunction with other provisions in water quality standards, including Section 62-302.500 F.A.C. [Surface Waters: Minimum Criteria, General Criteria] that apply to all waters unless alternative or more stringent criteria are specified in F.A.C. Section 62-302.530. In addition, unless otherwise stated, all criteria express the maximum not to be exceeded at any time. The specific criteria are as follows:

### **Nutrients**

The discharge of nutrients shall continue to be limited as needed to prevent violations of other standards contained in this chapter [Section 62.302 F.A.C.] In no case shall nutrient concentrations of a body of water be altered so as to cause an imbalance in natural populations of aquatic flora and fauna [Section 62.302530 F.A.C.].

### **Dissolved Oxygen (DO)**

Dissolved Oxygen (DO) shall not be less than 5.0 milligrams/L. Normal daily and seasonal fluctuations above these levels shall be maintained.



### **Biochemical Oxygen Demand (BOD)**

BOD shall not be increased to exceed values which would cause dissolved oxygen to be depressed below the limit established for each Class and, in no case, shall it be great enough to produce nuisance conditions.

## **EXAMINE WATER QUALITY AND ENVIRONMENTAL DATA**

The FDEP Water Quality Assessment Report describes that the status of surface water quality in the Tampa Bay Tributaries Basin was determined by evaluating three categories of data; chemistry data, biological data, and fish consumption advisories. The main source of water quality data was information collected between 1996 and 2003 and stored in the EPA's STorage and RETrieval (STORET) database. Other sources included the FDEP's Biology Database (SBIO) and fish consumption advisory and beach closure information from DOH. In order to develop the TMDL, these data sources and all additional available data was used.

### **Ambient Water Quality Data**

Biological data and chemical water quality data was assessed during the review and listing process. This data is summarized here as background information for the TMDL development. First, the biological data is discussed.

Itchepackasassa Creek scored excellent and good on 1996 SCI and poor on one 1995 SCI sample. It was considered not impaired under the FDEP bioassessment summary for 5 of 6 sample events. Also, two other segments of this creek (WBIDs 1524 and 1495A) were considered healthy based on the 1996 sample data. (FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION, Division of Water Resource Management Basin Status Report, SOUTHWEST DISTRICT • GROUP 2 BASIN • JUNE 2002)

A list of biological assessment results from FDEP's IWR database is shown in Table 1.

**Table 1: Biological Assessments for the 303(d) listed water bodies.(FDEP, IWR Database version 16\_2, 2004)**

WBID	Score	Method	Station ID	Station Name	Test Result	Date
1495B	Good	SCI	FLJUICEREF	ITCHEPACKESASSA Ck, ref site for Fla Juice FYI	23	4/29/1996
1495B	Good	SCI	ICHTP60TST	Itchepackasassa Ck @ CR 582	23	8/6/1996
1495B	Good	SCI	FLJUICETST	ITCHEPACKESASSA Ck, test site for Fla Juice FYI	21	4/29/1996
1495B	Good	SCI	FLJUICEREF	ITCHEPACKESASSA Ck, ref site for Fla Juice FYI	21	11/6/1995
1495B	Suspect	BIORECON	ICHTP60TST	Itchepackasassa Ck @ CR 582	2	10/25/2002
1495B	Poor	SCI	FLJUICETST	ITCHEPACKESASSA Ck, test site for Fla Juice FYI	19	11/6/1995
1495B	Suspect	BIORECON	IC10	Itchepackesassa Creek downstream of Kraft Rd bri	1	2/7/2002
1495B	Healthy	BIORECON	ICHTP60TST	Itchepackasassa Ck @ CR 582	3	1/31/2002

Next the chemical water quality data is summarized. Tables showing the water quality monitoring stations in each WBID and a summary of the water quality results are shown below.

**Table 2: Water Quality Observation Stations used in assessment for ITCHEPACKASASSA CREEK, WBID 1495B**

Station number	Station Name	First	Last Date
21FLWQA 280212708201460	itchepackesassa creek @ kraft road	10/18/1999	1/31/2002
21FLGW 8034	swb-ls-1019	8/23/2000	8/23/2000
21FLKWATHIL-ITREEK116-1	hillsborough-itchepackesassa creek-116-1	4/5/2000	12/19/2002
21FLKWATHIL-ITREEK116-2	hillsborough-itchepackesassa creek-116-2	4/5/2000	12/19/2002
21FLKWATHIL-ITREEK116-3	hillsborough-itchepackesassa creek-116-3	4/5/2000	12/19/2002
21FLTPA 24030081	tp60 - itchepackasass creek	1/31/2002	10/22/2002
21FLTPA 280159708200285	ic04-itchepackesassa creek	1/31/2002	2/10/2003
112WRD 02302260	itchepakesassa creek at s-582 nr knights, fl	5/9/2001	9/10/2001
21FLTPA 280304908201427	itche-2 itchepackasassa creek	5/30/2002	10/22/2002
21FLWQA 280615208206442	itche ck upstream of east canal	1/29/2002	1/29/2002
21FLWQA 280226108201472	itchepackesassa creek @ frontage rd south	10/19/1999	1/29/2002
21FLWQA 280232108201061	itchepackesassa creek @ galloway road	10/19/1999	1/29/2002
21FLWQA 280233408200475	trib to itche coming from lakeland golf course	10/19/1999	3/5/2002
21FLWQA 280304908201427	itchepackesassa creek @ swindell road	10/18/1999	1/31/2002
21FLWQA 280405608201528	itchepackesassa @ walker road	10/19/1999	1/29/2002
21FLWQA 280449408204227	itchepackesassa creek @ knights-griffin road	10/14/1999	1/31/2002
21FLTPA 280212708201460	ic10-itchepackesassa creek	2/7/2002	2/7/2002

ITCHEPACKASASSA CREEK is on the 303(d) list for Biochemical Oxygen Demand and low DO. For fresh waters the dissolved oxygen should not be less than 5.0 mg/L, and for assessments the dissolved oxygen should not be less than 5.0 in more than 10% of the samples.

**Table 3: Summary of data for ITCHEPACKASASSA CREEK**

Parameter	Obs	Max	Min	Mean	StDev	Violations	Florida Criteria
Dissolved Oxygen (mg/l)	57	9.98	0.56	4.87	2.27	29	5

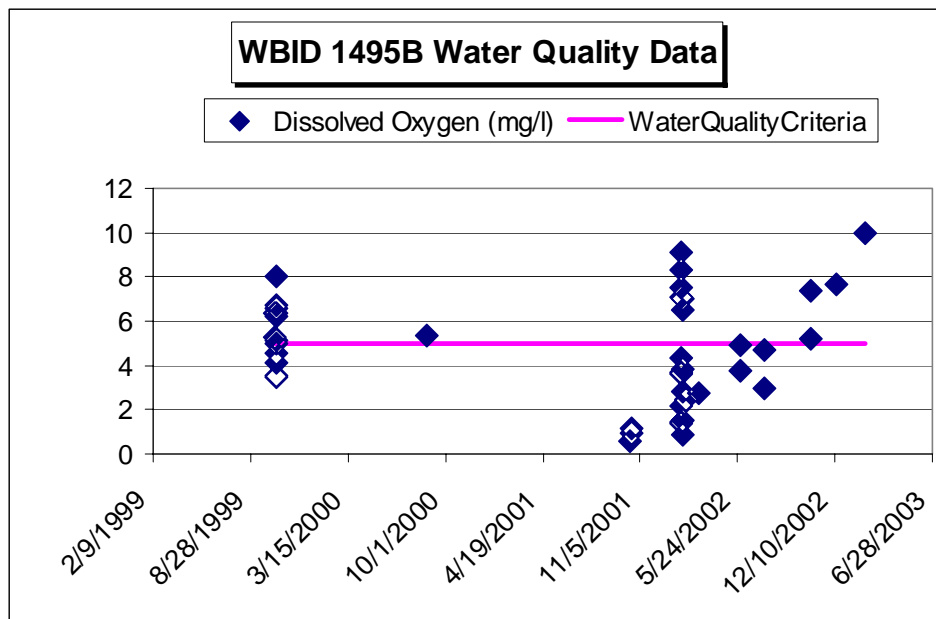


Figure 2: Median DO is 4.99 mg/l.

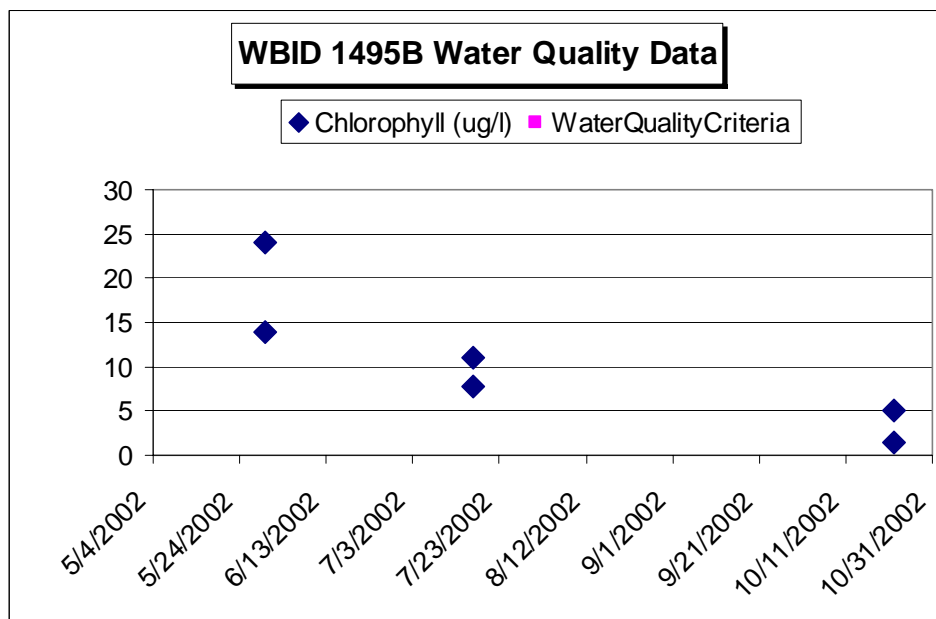


Figure 3: Median chlorophyll-a is 9.35 ug/l and the statewide median ranges from 3 to 4.

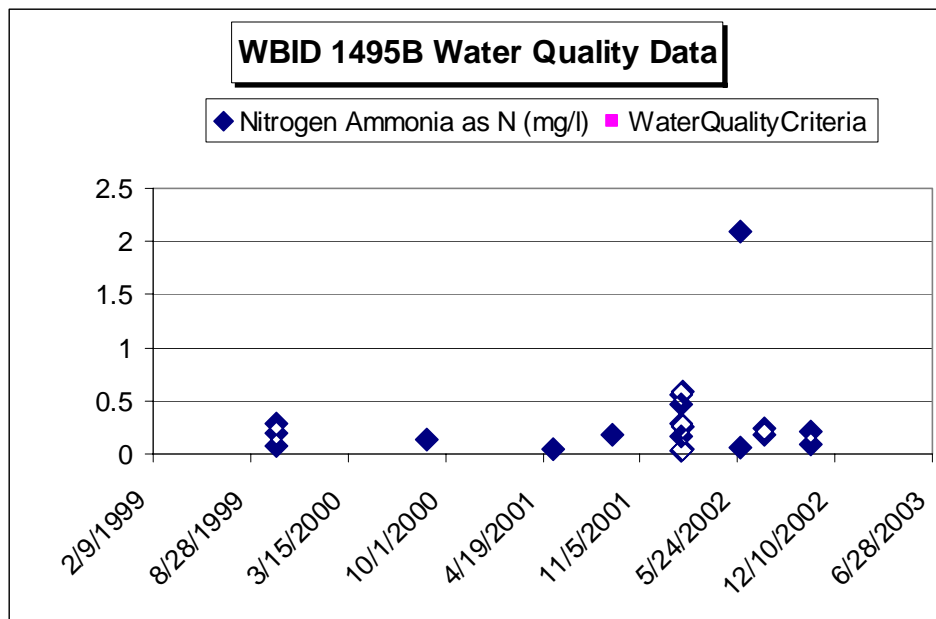


Figure 4: Ammonia median is 0.19 mg/l and the statewide median is 0.036 mg/l.

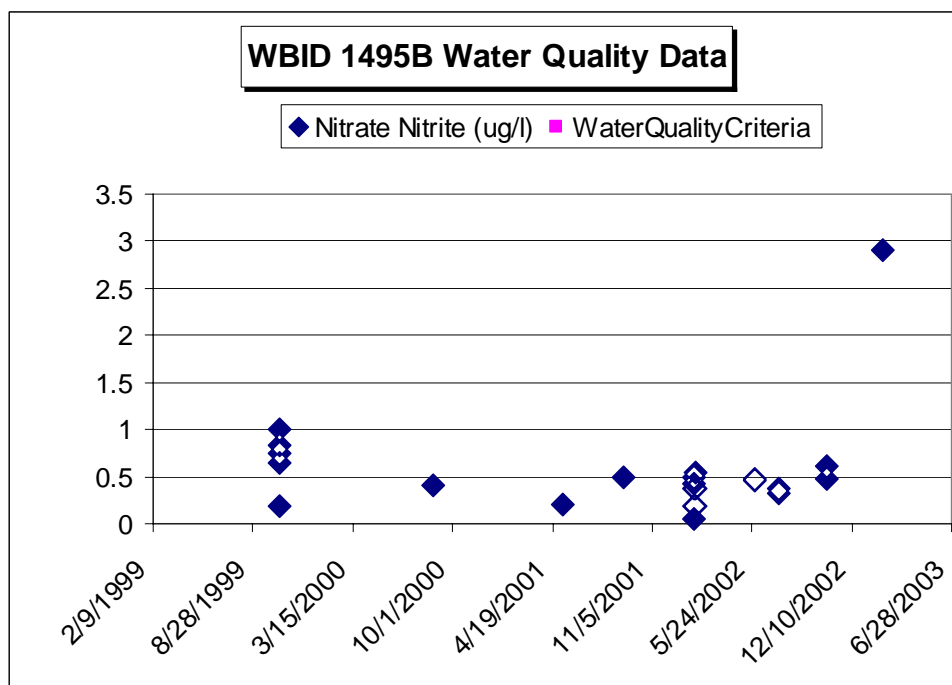


Figure 5: Median nitrate plus nitrite is 0.47 ug/l and the statewide median is 0.069.

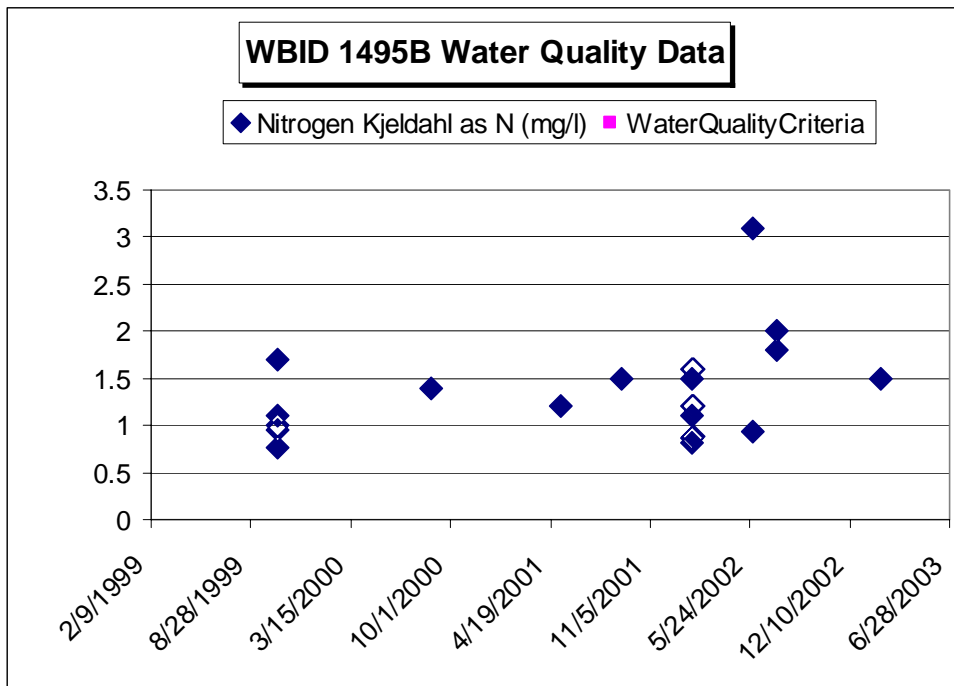


Figure 6: Median TKN is 1.1 mg/l and the statewide median is 1.1.

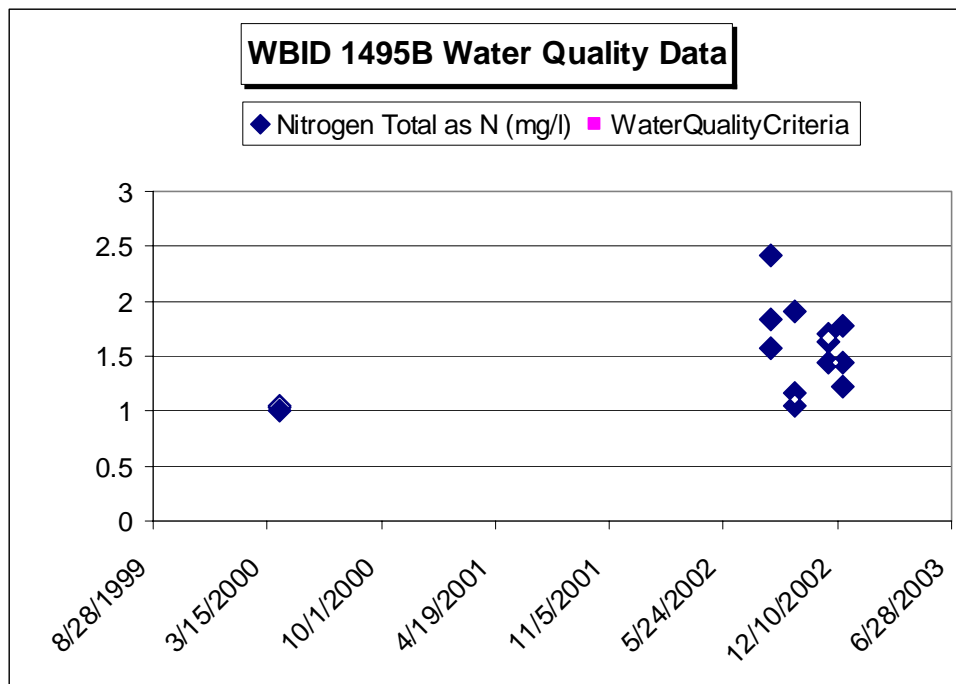


Figure 7: Median total nitrogen is 1.44 mg/l and the statewide median is 1.2.

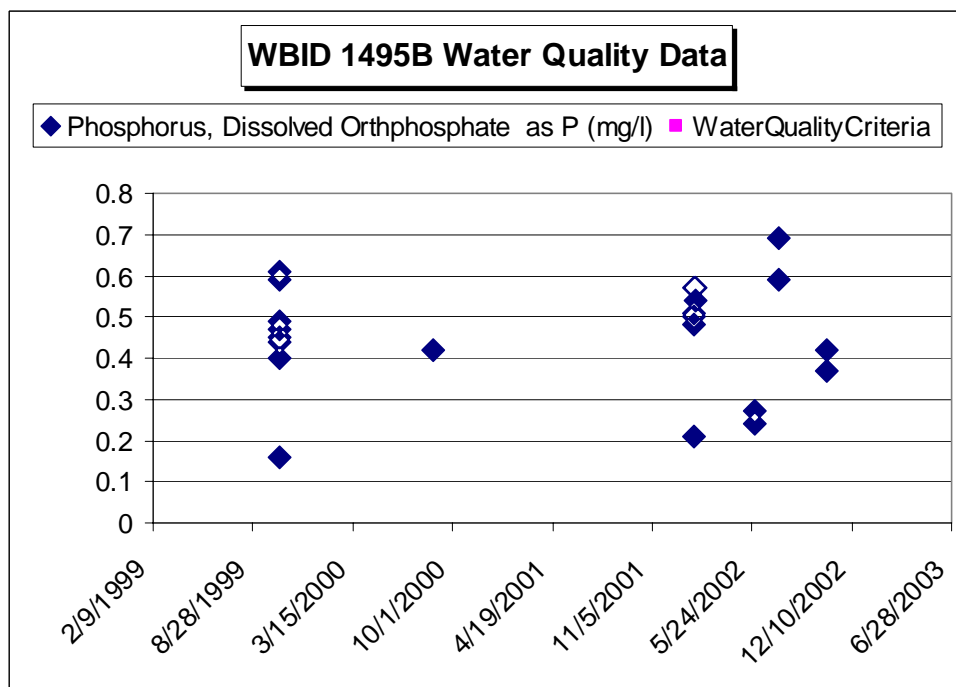
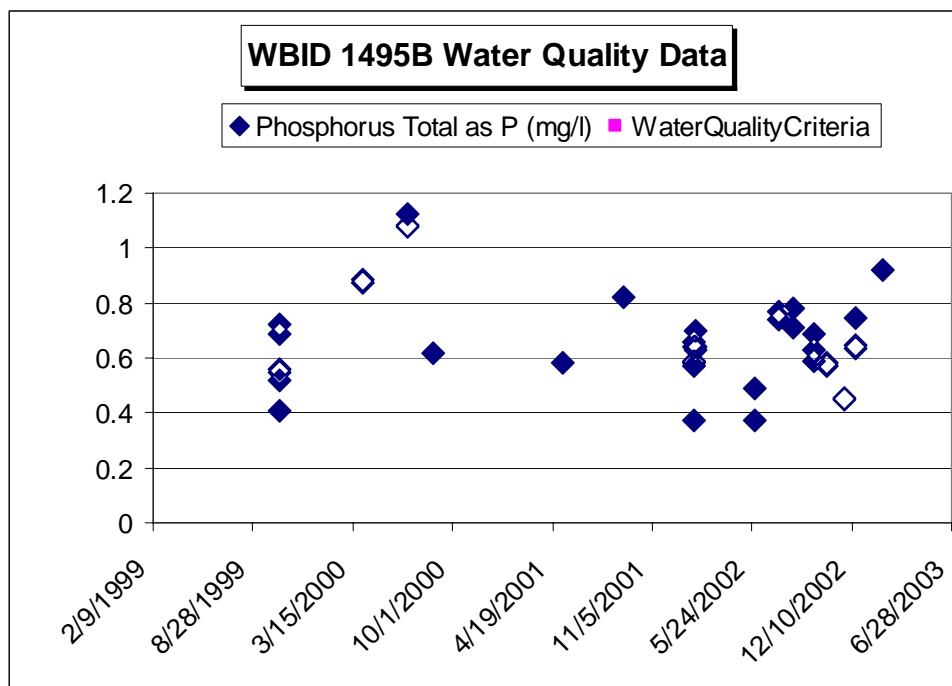


Figure 8: Median dissolved orthophosphate is 0.48 mg/l and the statewide median is 0.045.



**Figure 9: Median total phosphorus is 0.63 mg/l and the statewide median is 0.075.**

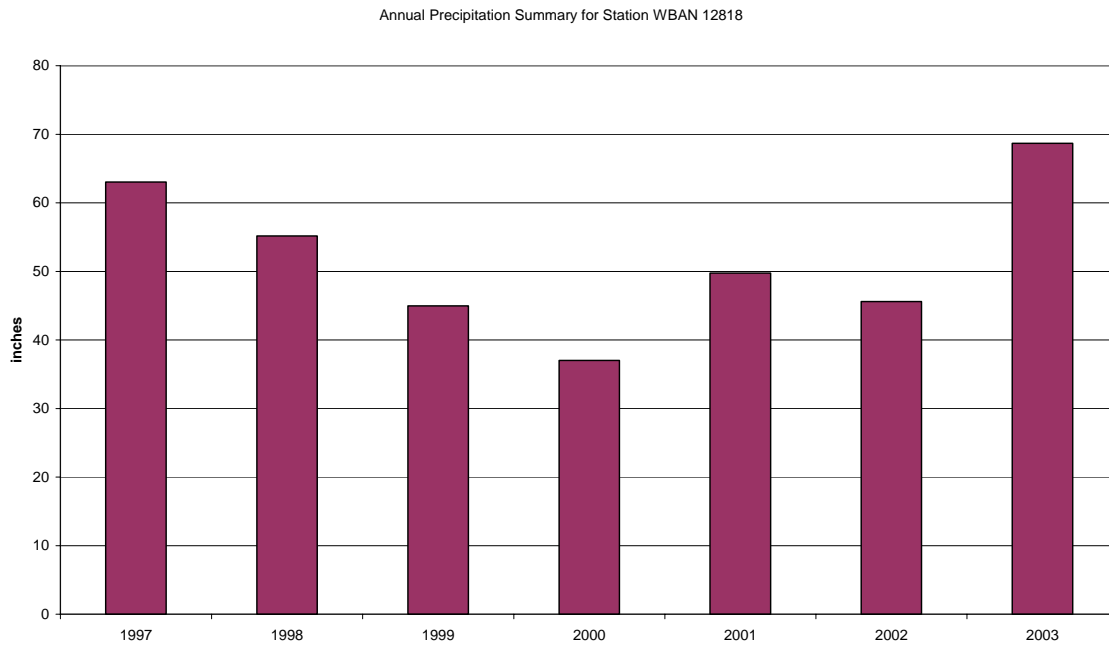
Dissolved oxygen (DO) ranges from 0.56 to 9.98 mg/l. Twenty-nine of 57 (51%) DO samples were below the criterion of 5 mg/l. As an indication of imbalance of natural flora or fauna, FDEP's IWR states a maximum annual mean value of chlorophyll-a should not exceed 20 ug/l or annual mean chlorophyll-a values should not have increased by more than 50% over historical values for at least two consecutive years. Itchepackesassa Creek chlorophyll-a data show one of the six samples slightly exceeded 20.

No BOD measurements were recorded in Itchepackesassa Creek.

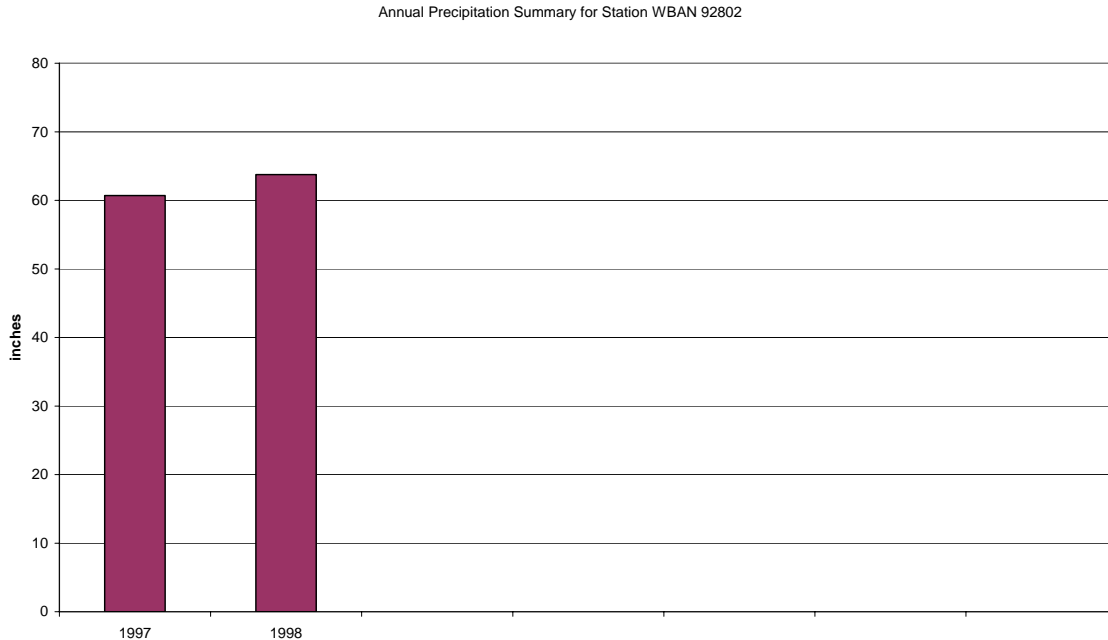
Median total phosphorus and total nitrogen is 0.63 and 1.44 mg/l, respectively. This gives a nitrogen to phosphorus ratio of about 2, which results in a nitrogen limitation and excess phosphorus in the water. Calculating similarly with the portions of phosphorus and nitrogen readily available to plant uptake, the ratio is 0.19 ammonia to 0.48 dissolved orthophosphate. This gives a ratio of about 0.4, which confirms the nitrogen limitation.

**Precipitation Data**

NCDC meteorological stations in the Hillsborough River Basin include two WBAN stations and three COOP stations. These are WBAN 12818 Brooksville, WBAN 92802 Newport Ritchie, COOP 083986 Hillsborough River State Park, COOP 088783 Tampa Fowler Ave., and COOP 087205 Plant City. Annual summaries of the precipitation recorded at these stations shows wet and dry periods in the years from 1997 to 2003.







## SOURCE ASSESSMENT

An important part of the TMDL analysis is the identification of sources or source categories in the watershed and the amount of pollutant loading contributed by each of these sources. Sources are broadly classified as either point or non-point sources.

A point source is defined as a discernable, confined, and discrete conveyance from which pollutants are or may be discharged to surface waters. Point source discharges of industrial wastewater and treated sanitary wastewater must be authorized by National Pollutant Discharge Elimination System (NPDES) permits. NPDES permitted facilities including certain urban stormwater discharges such as municipal separate storm sewer systems (MS4 areas), certain industrial facilities, and construction sites over one acre are storm water driven sources that are considered as “point sources” in this report.

Non-point sources of pollution are diffuse sources that cannot be identified as entering a waterbody through a discrete conveyance. These include nutrient runoff of agricultural fields and golf courses, septic tanks, and residential developments outside of MS4 areas.

<b>WBID</b>	<b>Residential (FLUCCS 1100-1300)</b>	<b>Comm, Ind, public (FLUCCS 1400- 1500,1700-1900)</b>	<b>Agriculture (FLUCCS 2100-2600)</b>	<b>Rangeland (FLUCCS 3100-3300)</b>	<b>Forest (FLUCCS 4100- 4400)</b>	<b>Water (FLUCCS 5100- 5400)</b>	<b>Wetlands (FLUCCS 6100-6500)</b>	<b>Barren &amp;Extractive (FLUCCS 1600,7100- 7400)</b>	<b>Transportation and Utilities (FLUCCS 8100- 8300)</b>	<b>TOTAL</b>
1495B	1054.04	1038.08	2581.96	420.83	1692.29	144.55	1302.62	13.52	182.46	8430.34

**Table 4: Landuse in acres**

### **Nonpoint sources**

Nonpoint sources that ultimately contribute to depletion of in-stream dissolved oxygen include sources of nutrients such as animal waste, waste-lagoon sludge, fertilizer application to agricultural fields, lawns, and golf courses, and malfunctioning onsite sewage treatment and disposal systems or septic tank systems.

The State of Florida Department of Health ([www.doh.state.fl.us/environment/statistics](http://www.doh.state.fl.us/environment/statistics)) publishes septic tanks data on a county basis. Table 5 summarizes the number of septic systems installed since the 1970 census and the total number of repair permits issued between 1996 and 2001. The data does not reflect septic tanks removed from service.

**Table 5: County Estimates of Septic Tanks and Repair Permits (FDEP, 2001)**

<b>County</b>	<b>Number of Septic Tanks (2002)</b>	<b>Number of Repair Permits Issued (1996 – 2002)</b>
Hillsborough	100,483	1,651

In 1982, Florida became the first state in the country to implement statewide regulations to address the issue of nonpoint source pollution by requiring new development and redevelopment to treat stormwater before it is discharged. The Stormwater Rule, as outlined in Chapter 403 Florida Statutes (F.S.), was established as a technology-based program that relies upon the implementation of BMPs that are designed to achieve a specific level of treatment (i.e., performance standards) as set forth in Chapter 62-40, F.A.C.

Florida's stormwater program is unique in having a performance standard for older stormwater systems that were built before the implementation of the Stormwater Rule in 1982. This rule states: "the pollutant loading from older stormwater management systems shall be reduced as needed to restore or maintain the beneficial uses of water" (Section 62-4-.432 (5)(c), F.A.C.).

Nonstructural and structural BMPs are an integral part of the State's stormwater programs. Nonstructural BMPs, often referred to as "source controls", are those that can be used to prevent the generation of NPS pollutants or to limit their transport off-site. Typical nonstructural BMPs include public education, land use management, preservation of wetlands and floodplains, and minimizing impervious surfaces. Technology-based structural BMPs are used to mitigate the increased stormwater peak discharge rate, volume, and pollutant loadings that accompany urbanization.

Landuse in the impaired WBIDs is shown in Table 4. The spatial distribution and acreage of different land use categories were identified using the 1999 land use coverage (scale 1:40,000) contained in the FDEP's GIS library. This dataset was derived from Ifarred Digital Orthophoto Quadrangle photo interpretations using the Florida Land Use Classification Code System (FLUCCS). Land use categories in the watershed were aggregated using the FLUCCS Level 2 codes.

### **Point sources**

There are six NPDES permitted continuous dischargers to the impaired waters addressed by EPA developed TMDLs in the Tampa Bay tributaries basin.

**Table 6: NPDES Facilities discharging to Impaired Waters**

NPDES	Facility	Receiving Waters
FL0026557	Plant City WRF(D001)	Westside Canal to Pemberton Creek to Hillsborough River (prior to 1997)
FL0026557	Plant City WRF(D002)	Blackwater Creek (after 1997)
FL0032581	CSX Transportation, Inc.	Winston Creek to Itchepackessassa Creek

Also there are municipal separate storm sewer systems (MS4) throughout the Hillsborough River Basin since the area is extensively developed. The MS4 areas by WBID 1495B are Lakeland, and Winston.

### **ANALYTICAL APPROACH/ MODEL SELECTION AND DEVELOPMENT**

Since this WBID was impaired for low DO, a water quality simulation model of the complex DO processes was utilized to analyze and develop a TMDL. Only seasonal trends of DO were simulated since DO violations of the standard were observed in the monthly trend monitoring data. The purpose of utilizing water quality models for the development of DO and BOD TMDLs in this stream system is to understand the linkage between the low in-stream DO and the factors that cause the low DO. The models can help determine which factors cause a greater effect than others. Some of the major factors in DO processes include watershed and stream flow and geometry, nutrient loads from the watershed, BOD loads from the watershed, in-stream plants and algae, and sediment oxygen demand.

The approach here is to model the Hillsborough River watershed hydrology, nutrient loads, BOD loads, then deliver these flows and loads to the impaired receiving streams, and finally model the in-stream water quality processes within these receiving streams. The major unknowns are the DO concentrations of the water flowing from the watershed into the receiving streams, and the BOD decay rates.

Due to the major unknown factors and the limited data, this model application is not intended to predict absolute DO values, but instead to predict the relative effect of nutrients, algae, and BOD on in-stream DO.

### **Mechanistic Model Approach**

WAM was utilized to simulate the watershed hydrology and water quality loads for most of the Hillsborough River Basin. WASP models were set up to examine the DO processes in the Hillsborough River mainstem and the major tributaries Blackwater Creek, Itchepackesassa Creek, Baker Creek, New River, and Cypress Creek. The WAM model was used to predict flows and loads which were then linked to the WASP models.

The following summary on of the WAM model is from EPA's Watershed and Water Quality Modeling Technical Support Center web site (<http://www.epa.gov/athens/wwqtsc/WAMView.pdf>). WAM's interface uses ESRI's

ArcView 3.2a with Spatial Analyst 1.1 (or 2.0). WAM was developed to allow engineers and planners to assess the water quality of both surface water and groundwater based on land use, soils, climate, and other factors. The model simulates the primary physical processes important for watershed hydrologic and pollutant transport. The WAM GIS-based coverages include land use, soils, topography, hydrography, basin and sub-basin boundaries, point sources and service area coverages, climate data, and land use and soils description files. The coverages are used to develop data that can be used in the simulation of a variety of physical and chemical processes.

WAM was developed based on a grid cell representation of the watershed. The grid cell representation allows for the identification of surface and groundwater flow and phosphorus concentrations for each cell. The model then “routes” the surface water and groundwater flows from the cells to assess the flow and phosphorus levels throughout the watershed. The model simulates the following elements: surface water and ground water flow allowing for the assessment of flow and pollutant loading for a tributary reach at both the daily and hourly time increment as necessary; water quality including particulate and soluble phosphorus, particulate and soluble nitrogen (NO<sub>3</sub>, NH<sub>4</sub>, and organic N), total suspended solids, and biological oxygen demand.

WAM was linked to WASP (SWET, 2003), which enables the simulation of dissolved oxygen and chlorophyll-a. The WAM model simulates the hydrology of the watershed using other imbedded models including “Groundwater Loading Effects of Agricultural Management Systems” (GLEAMS; Knisel, 1993), “Everglades Agricultural Area Model” (EAAMod; Botcher et al., 1998; SWET, 1999), and two submodels written specifically for WAM to handle wetland and urban landscapes. Dynamic routing of flows is accomplished through the use of an algorithm that uses a Manning’s flow equation based technique (Jacobson et al., 1998). Attenuation is based on the flow rate, characteristics of the flow path, and the distance of travel. The model provides many features that improve its ability to simulate the physical features in the generation of flows and loadings including:

- Flow structures simulation
  - Generation of typical farms
  - BMPs
  - Rain zones built into unique cells
- definitions, which also allows use with NEXRAD Data
- Full erosion/deposition and in-stream routing –is used with ponds and reservoirs
  - Closed basins and depressions are simulated
  - Separate simulation of vegetative areas in residential and urban
  - Simulation of point sources with service areas
  - Urban retention ponds
  - Impervious sediment buildup/washoff
  - Shoreline reaches for more precise delivery to rivers, lakes, and estuaries
  - Wildlife diversity within wetlands
  - Spatial map of areas having wetland assimilation protection
  - Indexing submodels for BOD, bacteria, and toxins

The overall operation of the model is managed by the ArcView-based interface. The interface allows the user to view available data, modify land use conditions, execute the model, and view results.

In order to evaluate the effect of BOD, nutrients, algae, and other oxygen demanding substances on DO processes a Water Quality Analysis Simulation Program (WASP) model was setup for this river segment. The Water Quality Analysis Simulation Program version 6 (WASP6) is an enhancement of the original WASP (Di Toro et al., 1983; Connolly and Winfield, 1984; Ambrose, R.B. et al., 1988). This model helps users interpret and predict water quality responses to natural phenomena and man-made pollution for various pollution management decisions. WASP6 is a dynamic compartment-modeling program for aquatic systems, including both the water column and the underlying benthos. The time-varying processes of advection, dispersion, point and diffuse mass loading, and boundary exchange are represented in the basic program. Water quality processes are represented in special kinetic subroutines that are either chosen from a library or written by the user. WASP is structured to permit easy substitution of kinetic subroutines into the overall package to form problem-specific models. WASP6 comes with two such models -- TOXI for toxicants and EUTRO for conventional water quality. Earlier versions of WASP have been used to examine eutrophication of Tampa Bay; phosphorus loading to Lake Okeechobee; eutrophication of the Neuse River and estuary; eutrophication and PCB pollution of the Great Lakes (Thomann, 1975; Thomann et al., 1976; Thomann et al, 1979; Di Toro and Connolly, 1980), eutrophication of the Potomac Estuary (Thomann and Fitzpatrick, 1982), kepone pollution of the James River Estuary (O'Connor et al., 1983), volatile organic pollution of the Delaware Estuary (Ambrose, 1987), and heavy metal pollution of the Deep River, North Carolina (JRB, 1984). In addition to these, numerous applications are listed in Di Toro et al., 1983.

The flexibility afforded by the Water Quality Analysis Simulation Program is unique. WASP6 permits the modeler to structure one, two, and three-dimensional models; allows the specification of time-variable exchange coefficients, advective flows, waste loads and water quality boundary conditions. The eutrophication module of WASP6 was applied to the Blackwater Creek in this study.

Flow, depth, velocity, and nutrient and BOD loads predicted by the WAM model was used in the WASP models. Solar radiation data was obtained on the University of Florida Institute of Food and Agricultural Sciences, Florida Automated Weather Network world-wide-web site <http://fawn.ifas.ufl.edu/>. Sediment oxygen demand (SOD) can be a major contributor to low D.O. SOD measurements in the nearby Alafai River range from 1.2 to over 7 grams/square meter/day, (Measured Sediment Oxygen Demand Rates, USEPA). SOD measurements in the Ocklawaha River Basin's Rice Creek upstream of the Georgia Pacific Mill discharge range from 1.5 to 3.0. SOD rate of 1.5 was used in this WASP model for Blackwater Creek. Incremental BOD and nutrient loads were entered into WASP from the results of the WAM model.

The estimated existing nutrient and BOD loads from the watershed are summarized in Table 7. The permitted annual average loads for the Plant City discharge are shown in Table 8. The CSX discharge is intermittent and small and is not expected to discharge

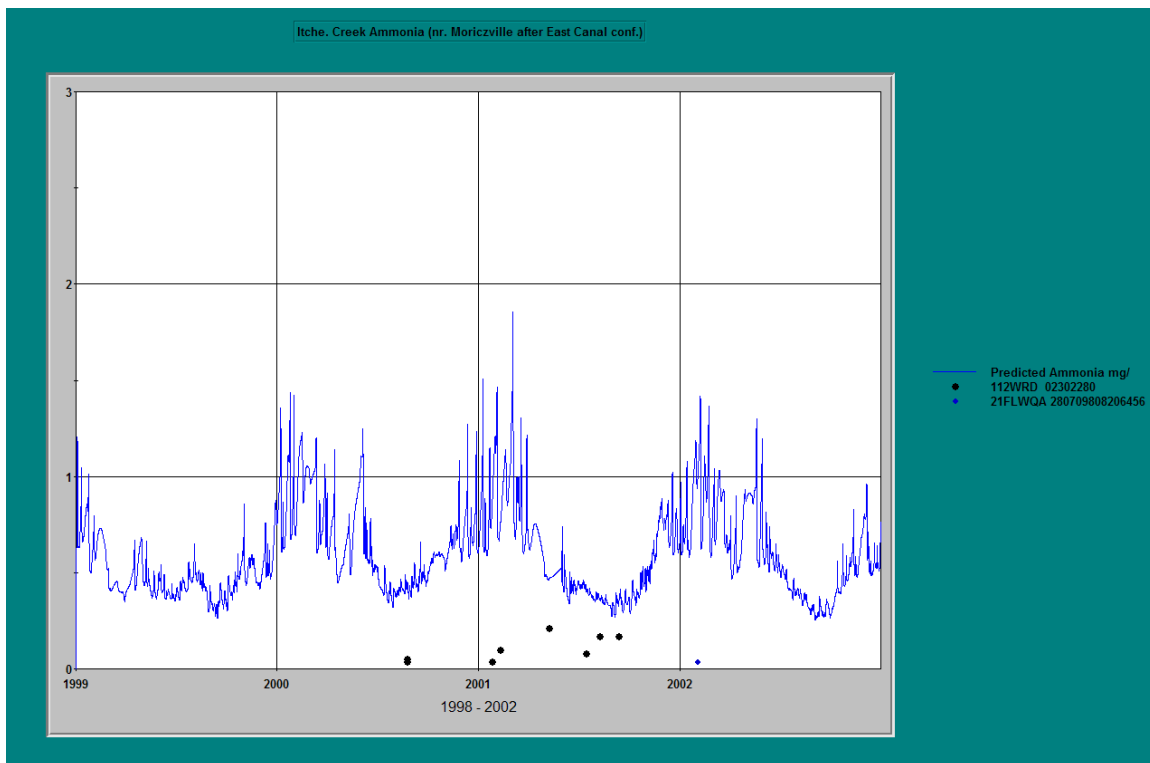
BOD or significant amounts of nutrients. Model predictions compared to observed water quality data are shown next.

**Table 7: Model predicted nitrogen, phosphorous and biochemical oxygen demand loads**

<u>Year</u>	<u>TN (kg/d)</u>	<u>TP (kg/d)</u>	<u>BOD (kg/d)</u>	<u>Annual Average Flow (m3/s)</u>
1999	87	23	178	1.10
2000	103	35	217	1.24
2001	148	46	376	1.75
2002	134	35	268	1.60
2003	171	43	359	2.22

**Table 8: Point source permitted loads**

<u>Point Source Facilities</u>	<u>TN (kg/d)</u>	<u>TP (kg/d)</u>	<u>CBOD<sub>5</sub> (kg/d)</u>	<u>Flow (m3/s)</u>
Plant City, FL0026557	30.4	10.1	50.7	0.12



**Figure 10: Predicted and observed ammonia**

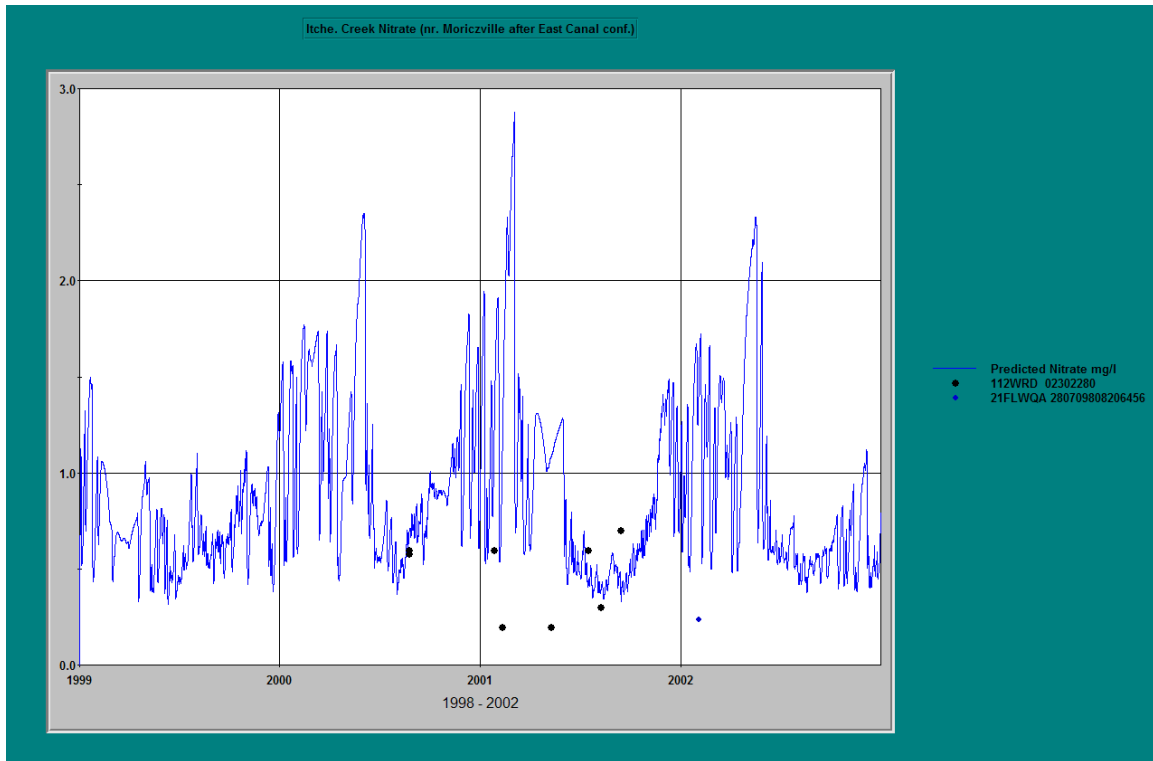


Figure 11: Predicted and observed nitrate

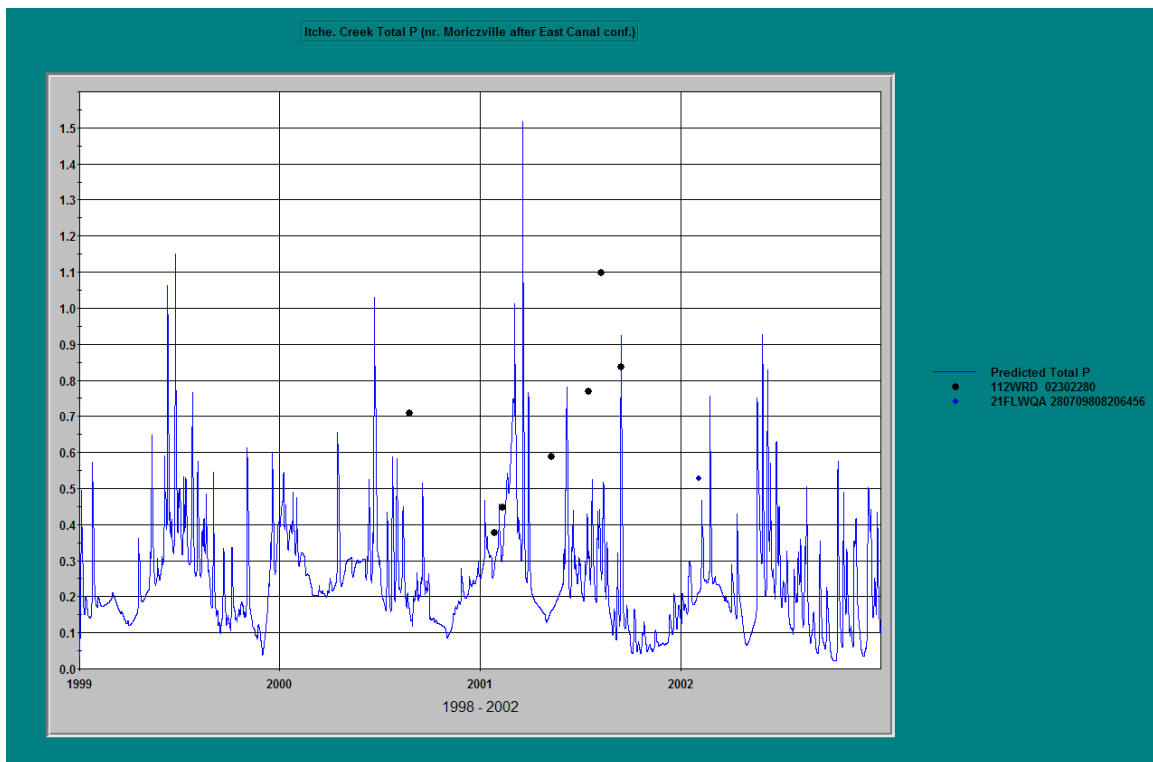


Figure 12: Predicted and observed phosphorous





**The TMDLs were developed by using the model to understand the river system and determine the levels of the water quality parameters that result in attainment of the DO water quality standard.**

As shown in **Error! Reference source not found.** and again in **Error! Reference source not found.** BOD is relatively low, near detection limits and has little impact on the DO in this river system. **Error! Reference source not found.** and Figure 13 show that the DO varies little with a three fold difference in BOD.

Nutrients can affect the DO through algae and other plant production and respiration. An excess of algae growth can imbalance the natural system and cause large DO swings from high super saturation to low levels. Additionally, the algae population can reach a limiting level of nutrients or light and then experience a large die-off, that can then result in DO consumption and low in-stream DO. **Error! Reference source not found.** shows that DO in this river system is not greatly affected by algae production. Excess growth of algae may be partially prevented by the naturally dark water in this system.

Sediment oxygen demand (SOD) is another factor that can contribute to low DO. However, based on measured data from similar streams and the model results, the SOD in the stream channel is likely not high enough to cause the chronic low DO found in this river system.

After examining each of the factors that can contribute to low DO, the levels of these factors found in the Itchepackesassa Creek system are not high enough to cause the chronically low DO found in this system.

The low DO in this river system is likely a result of natural processes in the ground water and wetlands flowing into these streams. Since the watershed model is not simulating the DO processes on the watershed and wetland areas, and the receiving stream model is simulating only the processes that occur in the streams, the DO levels in the water flowing from the wetlands to the streams is unknown. The sensitivity of the in-stream DO to the DO concentration of the water entering the stream from the watershed can be simulated by ranging these watershed DO concentrations. Figure 14 shows simulated in-stream DO with the watershed DO set to 2 mg/l and then at 5 mg/l. This demonstrates that if the water flowing from the watershed had DO concentrations of 5 mg/l then the in-stream DO would remain above the water quality standard. Note that the few days in June 2000 and Sept. 2001 during which the DO drops slightly below 5 mg/l are due to model upsets resulting from extreme high flow spikes, and are ignored.

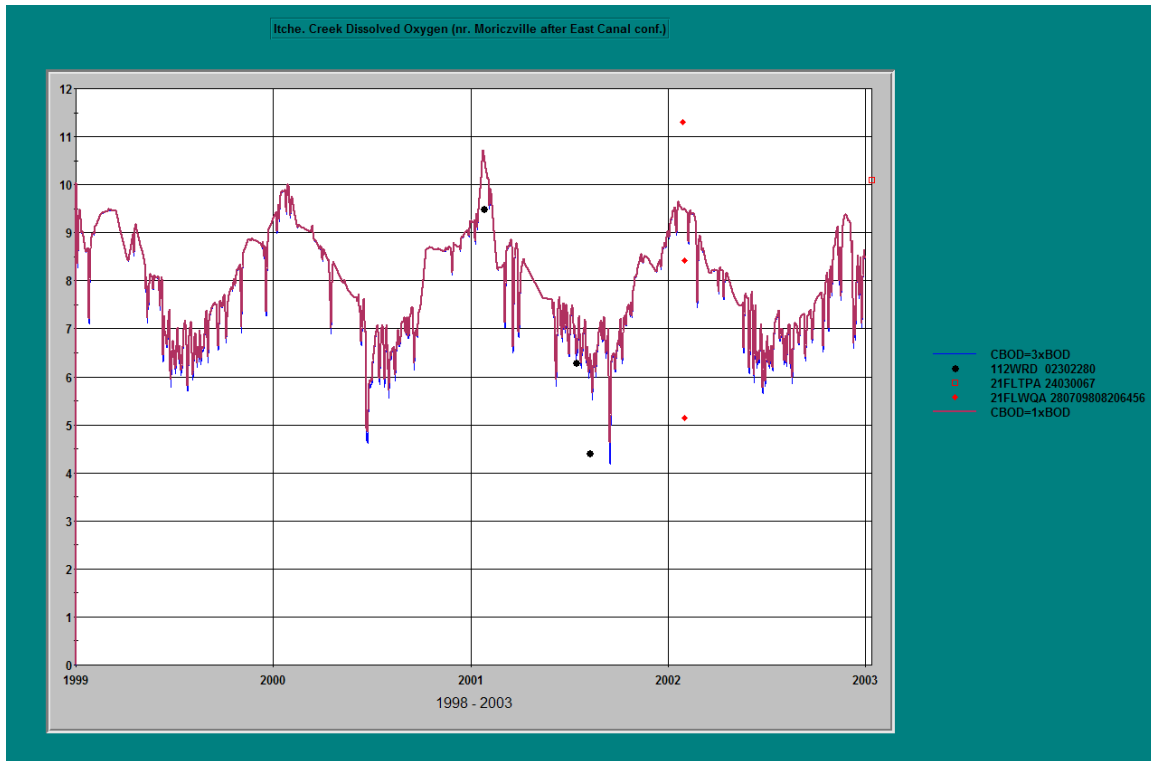


Figure 13: In-stream DO with in-stream CBOD at 1xBOD5 and 3xBOD5

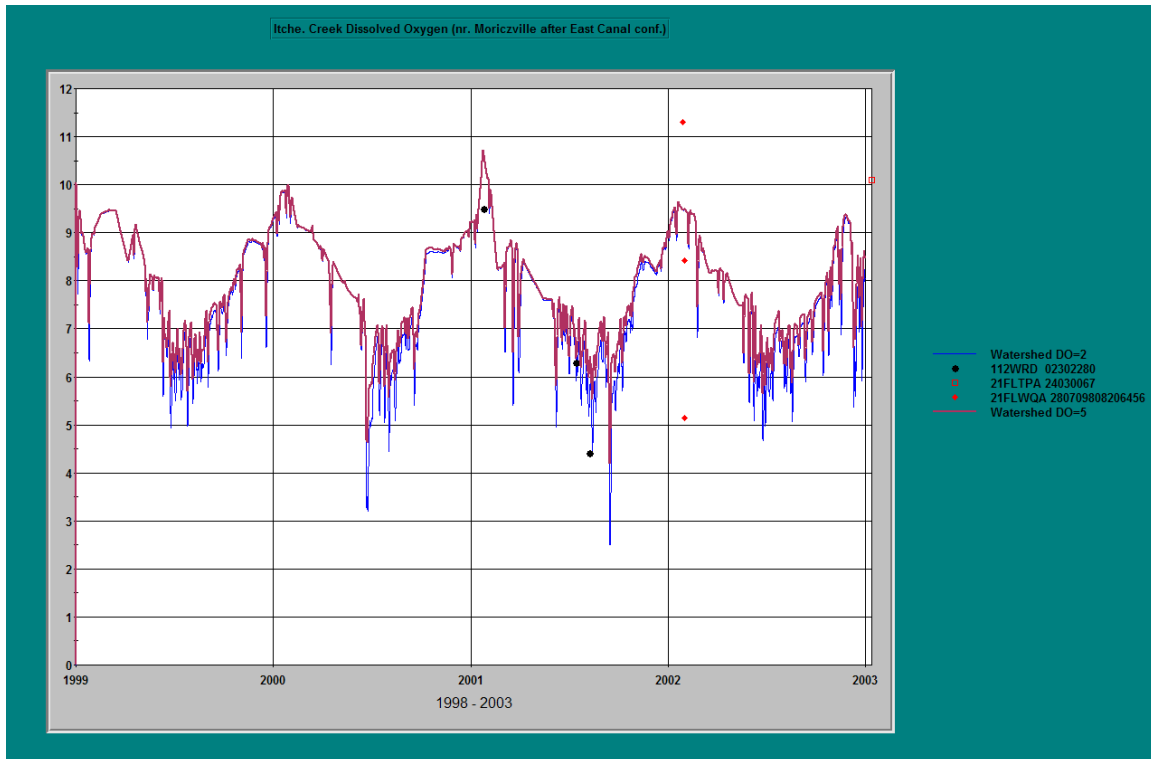


Figure 14: Instream DO with watershed DO concentration at 2 and 5 mg/l

## ALLOCATIONS

The TMDL and allocation of the load is shown in Table 9. Since the low in-stream DO is a result of low DO water flowing from groundwater and wetlands, and not the result of in-stream algae, nutrient, and BOD oxygen consumption, no load reductions are specified in this TMDL report. It is recommended that loads of nutrients and BOD be maintained at current levels. The TMDL for DO is the water quality standard of 5 mg/l and for BOD it is the current estimated annual average load of 376 kg/d. This DO concentration of 5.0 mg/l equates to 756 kg/d of dissolved oxygen in year 2001 when the flow was 1.75 cms. In order to achieve this standard in-stream, the water flowing from the wetlands and groundwater into the stream needs to be 5.0 mg/l. This groundwater and wetlands water is naturally below 5.0 mg/l. For this water to meet the DO standard of 5.0 mg/l, and addition of oxygen would be required. For example, to raise the DO from 2 mg/l to 5 mg/l, a flow of 1.75 cms (the average annual flow in 2001) would require an addition of 454 kg/d of oxygen. We recommend that a site-specific DO criteria be developed for Itchepackesassa Creek to account for the influence of natural low dissolved oxygen in ground water and surrounding wetlands under low flow conditions.

**Table 9: TMDL allocations**

Pollutant	TMDL	WLA		LA	MOS
		Continuous	MS4		
Dissolved Oxygen (DO)	5.0 mg/l or 756 kg/d	5.0 mg/l or 53 kg/d	5.0 mg/l or 703 kg/d	5.0 mg/l or 703 kg/d	implicit
Biochemical Oxygen Demand	376 kg/d	53 kg/d	292 kg/d	292 kg/d	32 kg/d

**Waste Load Allocations (Regulated with treatment plant and stormwater permits)**

The waste load allocation (WLA) is divided into continuous discharges from treatment plants and storm water loads from municipal separate storm sewer systems. The continuous WLA for DO is equal to the water quality standard of a minimum of 5 mg/l or 53 kg/d. For 5-day carbonaceous biochemical oxygen demand the continuous WLA is a maximum of 53 kg/d which is based on the current permit limits of 5 mg/l. The regulated storm-water loads should also be held at current levels which is specified as zero percent reduction of BOD and zero change in DO. The sum of the MS4 load and the LA should not be less than 703 kg/d DO, and not more than 292 kg/d BOD.

**Load Allocations (Non- Regulated)**

The sum of the MS4 load and the LA should not be less than 703 kg/d DO, and not more than 292 kg/d BOD.

**MARGIN OF SAFETY**

A ten percent explicit margin of safety is included in the allocation of BOD. This also implies an implicit margin of safety on the DO allocation.

**CRITICAL CONDITIONS**

Critical conditions were considered by analyzing a four year period containing wet, normal, and dry conditions. Since these impaired waters receive both storm water driven loads and continuous flow loads, both wet events and dry events were analyzed.

**SEASONAL VARIATION**

Seasonal variation was considered by analyzing a four year period containing all seasons and wet, normal, and dry conditions.

## **REFERENCES**

Florida Department of Environmental Protection (DEP), Basin Status Report for the Tampa Bay Tributaries Basin, DEP Division of Water Resource Management, Central District, Group 2 Basin, March 2003.

Florida Administrative Code (F.A.C.). Chapter 62-302, Surface Water Quality Standards.

Hillsborough County Environmental Protection Commission. Surface Water Quality 1996 – 2000 Hillsborough County, Florida.

National Agricultural Statistics Service (NASS), Agricultural Census for 1997, U.S. Department of Agricultural.

SWET. 2002. WAM Training Manual. Developed for EPA Region IV Training. Published by: Soil and Water Engineering Technology, Inc., Gainesville, FL.

USDA, 1997. 1997 Census of Agriculture, Volume 1, Geographic Area Series, Part 42, U.S. Department of Agriculture, National Agricultural Statistics Service. AC97-A-42, March 1999.

USEPA, 1991. Guidance for Water Quality –based Decisions: The TMDL Process. U.S. Environmental Protection Agency, Office of Water, Washington, DC. EPA-440/4-91-001, April 1991.

US Environmental Protection Agency – Region 4 Atlanta, GA, 2001, Water Quality Analysis Simulation Program (WASP) Version 6.0 DRAFT: User's Manual By Tim A. Wool, Robert B. Ambrose, James L. Martin, Edward A. Comer